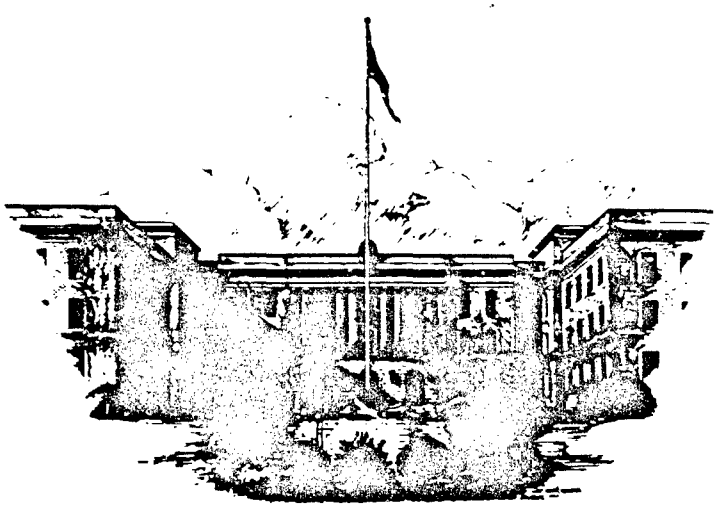
The Future Battlefield: Human Dimensions and Implications for Doctrine and Research



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THE FUTURE BATTLEFIELD: HUMAN DIMENSIONS AND IMPLICATIONS FOR DOCTRINE AND RESEARCH

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PREFACE

This paper is one of a series of occasional, informal accounts of work in the Division of Neuropsychiatry at the Walter Reed Army Institute of Research. The reports generally address topics in Army preventive medicine for which implementation responsibility lies significantly outside the Medical Department. Although their contents may overlap partly with our publications in the scientific literature, most papers are based on trip reports, briefings, and consultations involving specific Army audiences. Comments to the senior author are welcome.

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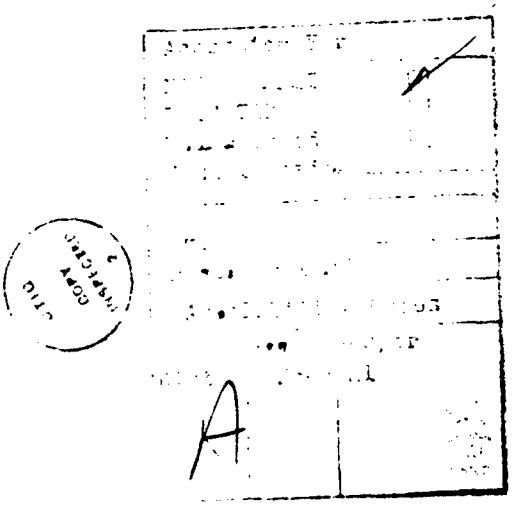
The material presented in this report is an expansion and reformatting of material prepared by the author for inclusion in an Ad Hoc Study Group Report to NATO Panel VIII. The changes that have been made were dictated by the desire to have this document stand alone and to reflect more accurately issues of concern to the United States Army. The author is deeply appreciative of the many supportive criticisms and suggestions made by colleagues from the WRAIR, the ARI, NATO, the Naval Medical Research Center, the U.S. Army Concepts Analysis Agency, and the U.S. Army Soldier Support Center. Helpful as these many individuals have been, they cannot be held responsible for any errors in the contents of this report.



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INTRODUCTION

Success on the battlefield depends in large measure upon the ability of commanders and leaders to exert control over the response of their troops to those elements of the strategic and tactical situation that define the nature of the battlefield. These battlefield elements create the environment within which soldiers must perform and, as such, constitute the set of situational variables that establish the character of the psychological and physiological demands which are placed upon soldiers. The demands placed on soldiers determine their capacity to sustain effective military performance.

Warfare must be considered one of the most demanding human occupations. The price of poor performance is not only high, but is often exacted with an immediacy that greatly increases the psychological and physiological impact of errors on combatants. The goal of combat is to break the opponents' will to continue an engagement while maintaining one's own capacity to fight. Poor performance and resulting errors sap the willingness of soldiers to sustain effective military performance when they face a deadly, confusing, and chaotic battlefield.

The capacities to sustain intellectual and cognitive effort, to maintain appropriate affect, and to accomplish hard physical work all degrade as a joint function of the intensity and duration of combat. Commanders and leaders must recognize and understand the operation of these factors and make their control an integral part of the preparation for and conduct of any warfare. The uniqueness of sustained warfare, as currently conceptualized, lies in the expectation of quantum leaps in combat intensity, a dramatic collapse in the time dimension of war, and the introduction of new technological capacities. Doctrine that is soundly based on the realities of the modern battlefield is required to guide both training and operations.

Currently, there is heated public debate in the United States concerning women in combat roles. Much of this debate is based on political and philosophical issues that are beyond the scope of this report. The commentary offered here is based upon the assumptions that:

a. significant numbers of women will be present in

forward and rear support areas;

b. these women will be engaged in critical military roles;

c. they will share in the risks created by long-range fires, air attack, attempted ground interdiction of rear areas, and nuclear/chemical threats.

Thus, female soldiers face the high probability of becoming casualties in significant numbers. Further, it seems highly probable that the exigencies of the highly mobile and fluid battlefield will, perforce, involve women directly in the hasty defense of threatened positions.

Various drugs have had long histories of use by soldiers on and near the battlefield. Alcohol, in all of its various potable manifestations, is perhaps the most common drug that has been used and abused by soldiers in battlefield environments. Opiates, cannabinoids, depressants, and stimulants have also been used whenever available. The usage patterns of these and other drugs has been both recreational and medicinal. Self-medication and utilization of informal sources of supply have been common patterns. The issues raised in this report are limited to the possibilities of developing and deploying drugs mainly as prophylactic agents against specific threats and in support of specific aspects of human performance. The nature of the prospective battlefield dictates that the predominant usage pattern of such drugs will, in all probability, be self prescription and self-medication.

One necessary component of the process by which military doctrine is developed must be a scientific data base whose content is appropriate to the realities and conditions of the prospective battlefield. This report will review those battlefield conditions, discuss their impact on soldier performance capabilities, and outline immediate and future research requirements for scientific work in support of the development of appropriate human technology and implementing doctrine.

This, most assuredly, represents an immodest set of goals. A work of this nature is necessarily projective, futuristic, and therefore doomed to be incorrect in its particulars. The pace of innovation and our inability to foresee all of the implications that flow from the intro-

duction of a particular new technological element guarantee the latter. However, the soldier as a biological entity remains fundamentally unchanged. Battles will continue to turn on his capacity to sustain and prevail under horrendous conditions. Therefore, we will take the soldier as our benchmark and our touchstone in an examination of the modern battlefield. If the report that follows leads to the kind of debate, discussion and action that will assist in the development of a more able and effective force, it will have achieved its goal.

MILITARY SITUATIONAL STRESSORS AND HUMAN PERFORMANCE FACTORS

The impact of the sustained battle on its participants must be understood in terms of three interlocking sets of variables.

The first set involves those situational features of the prospective battlefield that have undergone significant change in recent years. These changes involve variation and intensification of both the threats to be met and the requirements that must be mastered to produce combat success.

The second set of factors are composed of those elements that affect the performance capacity of individuals in any situation. They represent the translation of the general battlefield situation into those elements that impact directly on individual performance capacity. These factors characterize a particular work or operational position and affect any occupant of that position. For this reason, they are termed external factors.

The final set of factors characterize individual soldiers and represent the personal determinants of their performance capacity on the battlefield. These factors are susceptible to modification by interventions related to selection, training, preventive medicine, etc., and represent the basic elements of the preparation of soldiers for sustained warfare. These are termed biological factors.

The Battlefield Situation

Eight situational changes in the prospective battlefield that affect the nature of the threat and derivative requirements are identified and discussed.

The Evolution of Conventional Weapons. Combat will be conducted under conditions of unprecedented lethality that are attributable to the use of sophisticated conventional weapons. The nature of conventional weapons has and will continue to evolve and mutate in ways that increase the intensity and impact of the threats perceived by participants. There will be a similar evolution in the responses to new weaponry whose goal is to protect and defend. The interplay of threat and response, as interpreted by soldiers, will determine the psychological impact of these developments.

The Nuclear and Chemical Threat. Nuclear and chemical weapons will have a high probability of employment. The probability of employment will be high enough to make the threat of use a reality that affects the behavior of combatants. If chemical threat assessment leads troops to undertake protective measures, the impact of their actions on mobility and performance capability will approximate that of an actual attack. The contagious fear associated with the perception of imminent nuclear or chemical attack will provide fertile ground for the development and spread of insubordination, panic, or mutiny.

Command Initiative and Independence in Action. A widely dispersed battlefield, high mobility, electronic warfare and nuclear related EMPs will combine to make communications difficult, at best. A premium will be placed on independent action by maneuver units and on command initiative at all levels. It will be difficult, perhaps impossible, for more senior commanders to "see the battlefield" accurately and in a timely fashion. Therefore, more junior commanders must be prepared to maneuver and fight in effective isolation, guided only by broad tactical guidelines.

The Sustained Operations Requirement. Echeloned attack, night vision technology, and electronic warfare will increase the number of combat pulses per day experienced by the forward maneuver elements. The three to six pulses of combat per day experienced during heavy combat in

WWII can be expected to increase to nine to twelve pulses per day on the prospective battlefield. This increased temporal density of combat will create an increased performance demand on all combat support elements. The effect will be to force support elements into a sustained or continuous mode of operations. The requirement to repair damaged equipment in or very near to the forward are of engagement will expose support elements to near combat conditions. The exposure to casualties and fatigue that have always been the lot of the front-line soldier will penetrate more deeply into the force than has hitherto been the case except during major retrograde maneuvers.

The Night Operations Requirement. Night vision and related technologies will significantly increase combat activity during the hours of darkness and bad weather. Weapon systems whose target acquisition, aiming, and navigation systems habitually operate independently of ambient visibility will fight at night as during the day. However, weapon systems that depend for effective functioning upon broader human perceptual orienting capabilities will fight differently at night than during the day. The extensive use of smokes and obscurants to obtain tactical advantage will significantly alter the ground visual environment during daylight and adversely affect orienting capability. A narrowing of perceptual fields is a normal consequence of exposure to the stress of combat. The heavy dependence that will be placed on vision support systems operating in darkness and smoke may be expected to interact with this phenomenon.

The Rear Area Casualty Threat. The zones of immediate and potential lethality will extend into areas that heretofore have been relatively free of hazard. The actuality and threat of long range indirect fire, tactical air attack, and air mobile assault will change the nature of rear area operations. These threats will generate physical and psychological casualties at rates above those previously experienced.

Innovative Casualty Management. The conditions of the integrated, sustained battle environment will create unprecedented loads on medical support systems. At the same time, manpower limitations will place a premium on force conservation at all functional levels. Questions concerning who will receive what medical services, when and where, must be addressed.

Organization for Sustained Operations. The prospect of sustained operations at all command levels must be conceptualized as a forcing function that will have broad impact on organizational structure and procedure. Limitations on the capacity to sustain effective military performance must influence manning policies. The nature and role of reserve forces must be examined. Training that is specifically designed to prepare for sustained operations must be undertaken.

External Factors Affecting Performance Capability

The rate at which individual resources are expended in military performance is determined by the complex interaction of six external factors. These external factors determine the nature of the performance to be accomplished, where it is to be done, how it is to be done, and when it is to be done. The factors are independent of the individual doing the work and anyone occupying a particular position would face the same set of external demands.

Muscle Demands. Task-related requirements to utilize large muscle systems to move self, equipment and supplies around in the environment. Load levels, type of movements required, and speed of movement must be considered. All terrain features that impede or facilitate movement directly, or indirectly, e.g., through changes in vehicle handling characteristics, must also be considered.

Perceptual-Motor Demands. Task-related requirements for coordinated fine muscle movements as exemplified by the eye-hand coordination requirements associated with maintenance activities and the operation of many weapon systems. Target acquisition in optically aided systems and target tracking are prime examples. Since skill in meeting such demands generally requires extensive training, relief and replacement will create special management problems.

Cognitive Demands. Task related requirements for vigilance, information processing, communication, and decision making as exemplified by C3 activities. Under the very best of conditions, the environment of the battlefield is chaotic. The information that is absolutely necessary for effective cognitive functioning is often buried in a

confusing welter of noise. Often, the information needed to guide action is absent, insufficient, or qualitatively poor. At the other extreme, modern technology has the clear capability of providing too much information in ways which can overwhelm individual processing capacity. Personnel trained to meet cognitive demands are the most limited manpower resource. Since their actions guide the performance of others, their management poses especially difficult problems.

Emotional Demands. Situational elements related to the threat of personal harm, the killing and wounding of comrades, and other elements that induce intense anxiety and fear, perceptions of helplessness, higher states of arousal, and/or higher metabolic activity. Under conditions of extreme emotional demand, especially where individuals perceive that they are helpless and unable to influence events, they may become completely incapacitated. Emotional demands are heavily influenced by perception and experience. They will be highest during initial exposure to combat. While the intense fear stimulated by combat will not disappear, the experienced soldier will develop behavioral and emotional coping mechanisms that enable him to sustain performance. The impact of increasing levels of emotional demand on performance capability is not linear. Moderate to high levels of demand can facilitate optimal performance in well-trained individuals.

Environmental Demands. Situational elements related to cold, heat, altitude, humidity, rain, noise, vibration, motion, etc., constitute the major environmental demand elements. Loads created by the use of protective clothing must be considered. The impact of these elements extends beyond their effect on personal comfort. Human biology is characterized by a complex set of adjustment mechanisms that operate to maintain internal body conditions within relatively narrow boundaries. Environmental extremes, or extended exposure to lesser demand, will overwhelm the adjustment capacity of these mechanisms. The consequences of failure to maintain appropriate internal body conditions are ineffective performance, illness and incapacitation, and death.

Temporal Demands. Situational elements which determine when performance must be done, e.g., day or night, and the pace at which performance must be accomplished. In addition to the temporal patterning of performance demands,

the duration of demand without significant respite must be considered. Maximum performance sustainability is achieved when the pattern of activity and rest matches the pace of environmentally driven demands. The environmental day/night cycle has biological impacts that extend beyond changes in visibility. The entire internal economy of the individual undergoes a complex set of rhythmic variations over the course of twenty-four hours. This variation results in alterations in the body's capacity to respond and adapt to the entire range of external factors outlined in the preceding sections.

Internal Factors Affecting Performance Capability

While the constellation of external demands associated with a particular position affects anyone occupying the position, the impact of demands and the actual rate of resource utilization by a particular individual is also affected by five internal factors. These are:

Physical Fitness. The greater the aerobic and anaerobic capacity, i.e., stamina, an individual has, the lower the relative rate of resource utilization at work and the higher the relative rate of resource recovery with rest. While these relationships clearly hold for tasks involving muscle demand, there is ample reason to believe that they also influence cognitive work capacity as well. It is obvious that resources expended in the establishment and maintenance of high levels of physical fitness pay high dividends in the combat environment. It is less obvious that those same high dividends will accrue in the entire gamut of combat support operations. It is a central theme of this report that the pace of the modern battlefield will drive the entire operational chain that supports the combat soldier. Therefore, it follows that the loss of performance capacity and sustainability associated with poor physical fitness will be reflected throughout the force.

Age. Total resource capacity, rate of resource utilization and rate of resource recovery appear to vary with age. Rate of resource utilization appears to be directly related to age. Rate of resource recovery with rest appears to be inversely related to age. For present purposes, we beg the question of whether it is rate of

utilization, resources available, or some combination of both that is operative, the net effect is the same: older individuals tire sooner and require longer to recover than younger individuals. Age, in military contexts, is accompanied by higher rank and greater experience. Experience may lead to the adoption of behavioral strategies (such as pacing) which operate to increase performance sustainability. The increased responsibility that accompanies higher rank also operates to increase performance demand. How these factors interact in operational settings to modulate the impact of age on performance sustainability is not well understood. See Task Skills below.

Task Skills. The performance skills an individual brings to a task determine the facility with which performance can be accomplished. The congruence between task demands and task skills has a strong influence on psychophysiological activation. Increased performance effort results in a higher rate of resource utilization directly and indirectly in terms of increased levels of anxiety and frustration. Highly overlearned and practiced skills are less prone to disruption by competing demands, fatigue and other stressors. In addition to specific task related skills, more general issues concerning the organization and structure of work must also be considered. Maintenance of task prioritization, economy of work flow, and avoidance of extraneous demands have positive effects on both work output and sustainability.

Health Status. Many common diseases, e.g., upper respiratory infections or gastrointestinal distress, may not remove individuals from duty status, especially under high demand conditions. However, these diseases constitute a stressor which increases the rate of resource utilization and impairs resource recovery. Historically, infectious disease have been the major source of casualties in military organizations. Even in the face of enormous strides in preventive medicine and sanitation, infectious disease remains the prime casualty generator. The integrated battlefield is subject to disease hazards beyond those created by the use of biological warfare. Intense stress impairs normal immune system competence. Low level, nonlethal exposure to nuclear radiation lowers the capacity of the body's immune system to resist infection by common disease agents. Intermediate radiation doses are not immediately fatal but create a pattern of deteriorating health extending over days and weeks.

Psychological Fitness. The wartime environment is characterized by many sources of stress that are either not commonly present in peacetime or, if present, are attenuated in intensity. While the number and intensity of these psychological stresses increases with proximity to combat, projections for future combat indicate that wider areas of serious threat will expose greater numbers of soldiers to higher stress levels than have been generally experienced in prior wars. Modern technological capacities will open wide areas of the zone of communication to attack. Areas that in past experience were rightly perceived by soldiers to be safe will become areas of risk. Doctrine that calls for the dispersal of combat elements on the battlefield will increase unit and individual isolation. Isolation on the battlefield places a severe strain on individual coping resources. Stress increases the rate of resource utilization and impairs resource recovery. Thus, an individual's skill at coping with stress is a factor in performance sustainability. Training and preparation that increases both the range and quality of the soldier's psychological fitness will pay military dividends in the same coin as enhanced physical fitness.

MILITARY IMPLICATIONS

Leadership and Command

Good leadership and high morale can induce highly skilled soldiers to perform extremely well under very adverse conditions. However, there is a cost for that performance which mounts inexorably with continued demand and which must ultimately be paid. The stimuli of leadership and morale do not halt the complex process of individual resource utilization and will ultimately increase the rate of utilization as the effort expended is increased to meet demand. Essential military performance will remain intact for varying periods of time depending upon the weight of demands. However performance will slow down, future oriented and self-care behaviors will drop out and "dumb" errors will increase in frequency as fatigue exacts its price. It is an essential task of military leaders to utilize the human resources they command in a manner that will not only maximize the probability of successfully completing their current mission, but to conserve what

resources they can for the mission that will surely follow.

Leadership and the Control of Fatigue. Leadership can exercise this resource conservation role in the sustained operations environment by matching the capacities of men and the pace of their performance to the demands of the situation. This role assumes particular importance when replacements are at a premium, or simply unavailable. While casualties are a fact of war, unnecessary casualties are clear indicators of poor leadership. If commanders are otherwise well prepared, errors of omission and commission are often the consequences of fatigue that seriously impair cognitive functioning. These errors produce casualties.

Appropriate management of fatigue for the commander and his troops is a leadership function that cannot be denied. Work/rest discipline becomes an important issue in force conservation whenever soldiers must extend the intensity, duration, or timing of their activities. Under these conditions, leaders must not only be concerned with how soldiers do their work, but with how they take their rest. Effective rest discipline is heavily dependent upon the behavior of leaders who, through precept and example, set the behavioral expectations within a unit or staff organization. The leader who effectively delegates task responsibility among subordinates and then fails to avail himself of the resulting opportunity to rest, sets a poor example for others and himself suffers a self-inflicted wound.

A recent field study has shown that commanders and their staffs are likely to have strong personal views about what their own rest discipline should be. Sleep and rest are often planned for and taken in accordance with their views. Two weaknesses of this individualistic approach were observed. Commanders appeared to be insensitive to the impact their sleep/rest patterns had on subordinates and, their patterns bore little resemblance to what might be expected on the basis of a contemporary scientific understanding of the biology of sleep.

Leadership and Change. The successes and failures of military command and leadership are significant determinants of the outcome of battles and wars. It can be argued that leadership and command functions are most critical when technology rapidly alters the face of battle. The prospective battlefield is clearly one in which the nature of battle is undergoing radical changes, the implications

of which will be as profound as those that accompanied the introduction of the long bow, the repeating rifle, rifled artillery, and the machine gun.

Perhaps the most critical changes resulting from the new technology are those related to the increased intensity of combat and its compression in time. In terms of the exercise of command functions, months will become weeks, and weeks will become days. There will be very little time available for leaders and commanders to learn the new lessons that exposure to battle under new conditions inevitably teach. Perhaps the cliche that commanders prepare their troops to fight the last war, to the extent that it is true, represents the greatest hazard we face. Commanders must prepare their troops and themselves to fight the next war.

Recommendations for the Development of Doctrine. These preparations for battle must be supported by human factors research conducted with the same priority we devote to the development of weapons systems. While the battlefield remains the ultimate testing ground of military technology and doctrine, it is a poor laboratory for their research and development. Areas requiring concentrated effort include:

Training for sustained operations. The development of effective training methodology to prepare troops to fight, survive, and win under sustained battle conditions. The many difficult political and social issues that surround realistic, and thereby more hazardous, training must be addressed. Training time for soldiers in garrison is scarce due to the many requirements to address non-mission related needs of the soldier. Training for sustained operations is expensive. Equipment used in such training is likely to suffer damage which, while painful to the "zero defect" mentality, provides an excellent opportunity for the realistic training of support personnel. The requirement that commanders specifically address and implement appropriate rest doctrine for their troops and for themselves must become an integral part of their own performance evaluations.

Development and maintenance of small group cohesion. The development of techniques to produce rapid and effective military group cohesion at the company level and below. Particular attention must be paid to the problems associated with the reconstitution of survivors and the

integration of non-combat arms personnel into effective military units. The integration of replacements into small units normally occurs after some shared combat experience. Until this bonding takes place the replacement is at significantly higher risk than are his comrades. The same can be said of a unit composed of strangers. The compression of time on the modern battlefield dictates that this natural process be accelerated, if possible.

Maintenance of interpersonal communications. The refinement of techniques for maintaining effective vertical and lateral communications for the purpose of minimizing confusion within and between units. Emphasis here is placed on the informal communications that not only promote bonding between soldiers and between soldiers and their leaders, but which also serve to reduce the uncertainty that is a significant stressor in battle.

Command decentralization. The refinement of techniques for maintaining effective command functioning while at the same time maximizing subordinate initiative and sustaining decentralized functional capacity. The tactical requirements for dispersion, concealment, communications discipline, and night operations will significantly increase the loads on small unit commanders and leaders. Given the expected lethality of the prospective battlefield, careful attention should be paid to the question of sudden and widespread command succession.

Impact of casualties on leaders. The burden of casualties affects all soldiers in a unit, but perhaps none so greatly as the unit leader. Issues related to conditioning commanders at all levels to cope effectively with high casualty rates must be explored. The issue must be approached not only from the perspective of maintaining unit effectiveness, but also in terms of reducing intense and debilitating psychological stress and maintaining effective command performance.

The Distribution of Performance Loads: Shiftwork

We define performance sustainability as that period of time during which competent performance can be maintained without the intervention of significant situational changes

that provide release from work requirements. A period of release from these requirements normally involves a period of rest. However, such periods may also include a variety of other behaviors, including self-maintenance, recreation, and occasionally, other less demanding work. The critical factor for maintaining performance capability appears to be the temporary reduction of performance requirements.

A General Performance Sustainability Model. In general, the demand characteristics of work determine the rate at which individual resources are expended. Rest restores resources and makes them available for expenditure in future performance. If the resource depletion created by performance demands is matched by the resource restoration provided by rest, then the equation balances and a particular work/rest schedule can be expected to maintain itself indefinitely. If, on the other hand, resource depletion exceeds resource restoration, a net resource deficit accrues. Typically, the imbalance is redressed by the interpolation of longer periods of rest that may require days. Serious resource deficits may require weeks of altered activity to achieve full restoration of performance capacity.

Shiftwork Recommendations: A Caveat. It is clear that tasks and situations differ widely in the wartime environment. It is also clear that there is broad individual variation in terms of the psychobiological factors listed above. The critical determinant of the performance sustainability of a particular individual, in a particular job and setting, is a function of a complex interaction between the previously discussed external and internal factors. Very little scientific research bears directly on the interaction of these factors as they operate in concert, and in wartime environments. Previous research has focused on single factors or, at most, on small subsets of factors. There is reason to believe that the impact of the factors does not combine in a linear fashion, but that they interact in a synergistic manner. Under this condition, simple summation and extrapolation from single factor research findings will likely lead to overestimations of performance sustainability.

The Organization of Performance Periods. Three separate periods must be considered if performance is to be organized in a manner that permits work to be sustained and effective over some target period of time. These are:

a. the work day,

b. the work week, and

c. the work month.

The method of organizing performance periods depends upon the most important features of the environment that create the performance demand and upon the personnel resources available to meet the demand. If the environmental demands are very great, attention must be centered on the work day since it is the longest required period of unbroken activity that controls the need for subsequent restoration periods. If restoration cannot be accomplished within the framework of the work day, the work week must be carefully organized, and so on. If, on the other hand, long-term sustainability is the central issue, the organization of performance should proceed backwards to the work day from the longest performance period that is required. Continued high performance demand, attrition of the force, and the absence of replacements will provide a set of conditions under which the performance/restoration equation cannot be balanced. Resource deficits will mount inexorably and the rate of production of fatigue-related casualties will increase as operations are sustained in time. Realistic planning requires that close attention be paid to minimizing the rate of increase of such casualties. It is wishful thinking to believe that fatigue casualties can be eliminated from the prospective battlefield.

Shiftwork on the Battlefield. The demands of the prospective battlefield will require shiftwork wherever and whenever possible to sustain performance capacity. The exact nature of that shiftwork must depend upon the availability of soldiers, the interaction of the factors that determine workload, and the projected period of sustained operation. No single prescription can be given.

The performance demands in the vicinity of the forward areas of contact will be such that rest will be fragmentary at best, and it will be dictated by the nature of the battle. Forward support elements will find themselves with neither the manpower, the immediate support base, nor the opportunity to mount effective shiftwork schedules. These soldiers will operate in much the same way as the combat arms in terms of sustained periods of activity with too few

opportunities interspersed for rest. The fragmentary rest episodes available to such soldiers will be of poor quality and unlikely to prevent the accumulation of significant fatigue loads.

Further to the rear, troops will have the resources and the opportunity to organize their activities into shifts in order to sustain performance. Shiftwork models based on civilian patterns will probably be adequate in far rear areas and in occasional instances further forward. However, this problem represents an urgent priority for research. Such research must be coordinated with manpower planners in order to capitalize on reciprocal feedback.

Historical Experience. A U.S. Army regulation that has been in force since 1944 states that the total work time available to soldiers is 12 hours per day, 365 days per year for a total of 4,380 manhours. The regulation is silent on the subject of how those twelve hours are to be distributed across the day. Historically, commanders have resorted to a variety of shiftwork schemes in order to fulfill mission requirements. Perhaps the most familiar of these is the maritime watch system that employs basic four hour duty periods and eight hour rest periods that alternate around the clock. This system also employs two short watches called dog watches that have the effect of cycling a crew member's work periods through every hour of the day and night over a period of time. Two and four hour guard duty rotations have also been commonly employed.

In each case, the shiftwork system that evolved for particular applications was the result of a set of considerations involving the desired outcome of the work, the availability of personnel, and a perceived set of human limitations respecting work sustainability. Such factors as the rigors of weather, the duration of physical effort, and the ability to maintain vigilance all played a role in determining the work schedule that evolved into common use. However, due caution should be exercised in applying military precedents to contemporary needs. For example, guard duty on a picket line and guard duty mounted in front of an electronic warfare monitor scope both require intense vigilance and sustained concentration. However, performance sustainability in each case will be different.

An Empirical and Pragmatic Approach to Military Shiftwork. The foregoing suggests that no single system-wide work/rest doctrine will meet the full range of support

activity requirements. Instead, an integrated family of such doctrines must be developed in which each is particularized to meet the operational requirements of different combat and support elements. Training for sustained operations can provide the proving ground on which the operation and effectiveness of shiftwork schedules are tested and verified. Candidate schedules should be selected on the basis of an analysis of both civilian and military experience. Both concern for and research on the industrial hygiene of shiftwork have been areas of increased activity during the past decade on both sides of the Atlantic. The existing data base can serve as a useful basis for the development of rationalized military applications.

Strategies for Supplementing Performance Sustainability

The previous discussions have emphasized control of the distribution of work and rest periods as a means of extending performance capability. The general approach taken has been to maximize opportunities for rest within the constraints established by local battlefield situations. In this section, the discussion will center on some strategies for improving performance sustainability by altering the way in which soldiers do their work and exploit their opportunities to rest.

The Alteration of Internal States. The soldier who cannot take full advantage of all opportunities to rest is not only spending his resources without purpose, but is incurring an additional fatigue debt that will limit his future performance potential. While this is relevant for all soldiers, it is especially important for commanders and leaders who bear special responsibility for the care of their troops. The accumulation of sleep debt over time awake is inexorable. The very nature of the commanders' role dictates that they will have fewer opportunities for rest than their troops. Therefore, it is imperative that they derive full benefit from available opportunities to rest.

There is a body of contemporary research which strongly suggests that individuals can learn to alter their internal physiological states in desired directions.

Techniques for achieving clinically significant alterations in muscular tension and in parasympathetic/sympathetic nervous system balance are now routinely taught to a variety of patients for the purpose of achieving desirable therapeutic goals. A closely related body of research suggests the existence of a biological mirror image of the classical "fight or flight" reflex that is associated with intense sympathetic nervous system activation. It is suggested that these lines of work be extended and developed to create appropriate military behavioral technologies for improving soldier sustainability on the battlefield.

The Alteration of Individual Behavioral Functions. Fatigue significantly alters an individual's capacity to both sustain attention to a particular task and to divide available attentional capacity between two or more tasks. In the first case, highly relevant cues and signals provided by the environment are more likely to be missed as fatigue loads accumulate. In the latter case, the outcome of a failure to divide attention successfully are likely to be more complex.

Many actions on the battlefield depend upon maintaining a blending of requirements to respond to immediate demands as well as to respond in preparation for meeting foreseeable future demands. Immediate response demands have greater salience for the control of behavior than do future response demands, in the best of circumstances. Under conditions of intense fatigue, the maintenance of appropriate task prioritization fails and, in extreme cases, individuals adopt a purely responsive mode of activity. Ultimately, even the responsive mode of action fails.

Even in cases where some rest is possible, individual performance will benefit from the use of mnemonic aids, time structuring techniques, and other similar performance supports as means of combatting fatigue-induced cognitive deficits. The learning and use of such strategies should not be left to chance and individual whim. Instead, their employment should become an explicit part of the preparation and training for sustained operations.

Group Behavioral Functions. In modern warfare, individuals perform as members of small teams and crews that are organized as functional units. The manner in which such teams function in high demand environments is profoundly affected by the way in which they distribute their

activities. Task distribution to spread workloads and task sharing to provide redundancy and quality control are important principles to be followed in sustained, high demand operations.

The fundamental principles involved are quite straightforward and well-known. If individual attention is likely to be defective, then provide redundant capacity to detect signals or to catch errors. If individual attention cannot be successfully divided among tasks, then redistribute the requirement between people. It is too late to put these principles into effect once combat has begun. Once again, the strong recommendation must be that the use of such performance supports be made an explicit part of preparation and training for sustained operations.

Technological Support for Sustained Operations. The interface between the soldier and his weapon system must always be structured in a fashion that meets the needs of both men and systems. However, since the requirements of the weapon system are the product of design and engineering decisions, they are more readily modifiable than are the biological capacities of the soldier. Further, it is not sufficient to design a system interface on the basis of the capacities of the optimally fit operator. The issue here goes beyond that of the soldier who has marginal performance capacity when well-rested to that of any soldier performing under the loads imposed by the sustained battle.

Designers must not only answer the question "Can this system be operated effectively under high fatigue?", but, "Will this design actively support performance under conditions of high fatigue and stress?" Automation simply to reduce workload and skill requirements provide only a partial solution to the problems under consideration. The remainder of the solution must rest upon the utilization of computer technology to monitor, assess, and support operator performance capacity wherever possible.

For example, the content, sequence, and timing of most military tasks are, by design, highly standardized and formalized. Long military experience has shown that such task structuring, accompanied by extensive task overlearning, produces performance that is resistant to the impact of fatigue and stressors. The content, sequence and timing of operator inputs to weapon systems contain information about the psychological and physiological status of

the operator. A truly "intelligent" system would be programmed to monitor and evaluate these input characteristics, to recognize the status of the operator, and to use that information to aid the performance of the operator.

More is intended here than simply the addition of new alarms, prompts, and simplified displays. Machine interfaces that incorrectly assess the competence of the operator are counterproductive. Unnecessary alarms are soon ignored and the attendant danger that real alarms will be similarly ignored quickly rises. Excessive prompting is an impediment to skilled operation and, under appropriate conditions, complex displays can facilitate performance. What is being suggested is the sophisticated application of these performance supports when their utility has been automatically determined by the system.

Unit Reconstitution and Unit Replacement

If attrition of forces in the Covering Force Area (CFA) and the Main Battle Area (MBA) approaches expected levels and if reserves who have been committed relatively early in the engagement suffer similar losses, then the issue of unit reconstitution will assume great importance. It is highly likely that units, rather than individuals will be replaced. It is also likely that these replacement units will be created ad hoc from the remnants of other combat units, from returned casualties, and as a result of levies from among support units.

Procedures must be developed for hastily converting those aggregations of soldiers into combat units. It has been suggested that preparations for this contingency can be made during training through a combination of the cross training of generalizable skills and specific training in unit reconstitution. Historically, groups of soldiers given appropriate leadership have been able to reorganize themselves into effective fighting units. However, the concept has not been worked out and developed as doctrine for modern battlefield conditions.

Casualty Management

Throughout this chapter, there have been references to the lethality of the projected battlefield and to casualties. The emphasis has been on the management of the impact of casualties on the force. In this section, we discuss the management of the casualties themselves. In recent combat, better than ninety percent of the wounded who reached medical care survived. Trauma medicine has achieved an extremely high state of development. Knowledge of the high probability of survival following wounding is common among the troops and is a significant factor in morale.

The lightly wounded may be a significant source of replacement manpower in rear areas. Issues related to rates and locations of casualty generation and the types of casualty to be expected must be closely examined in order to develop appropriate doctrine concerning casualty management.

Expected Rates of Casualty Generation. The first issue concerns the expected rates of casualty generation. All commentators expect these rates to be higher than those suffered by forces during World War II and Korea who were exposed to intense combat. However, there is considerable disagreement concerning what those rates will be. The issue is complicated by the fact that most of the readily available data refer to the conventional battlefield. The use of nuclear and chemical weapons on the integrated battlefield can be expected to act as highly significant casualty multipliers. Until reasonable data for expected casualty rates are available, realistic doctrine respecting casualty management cannot be produced.

The Loci of Casualty Generation. The second issue concerns the locations in which casualties will be generated. There appears to be general consensus that the highest number of casualties will be generated in the forward areas of contact as has been true historically. However, Warsaw Pact doctrine clearly states the intention to create maximum possible disruption in rear areas. The extension of significant casualty generation into rear areas will create new problems for medical support systems.

The extended and dispersed nature of the forward areas of contact, combined with rapid movement will create new

problems of achieving the kind of rapid evacuation that has been in good measure responsible for the high survival rates of the wounded. The medical technology needed to stabilize the wounded must be modified in a manner which permits it to be moved forward into effective range of the forward areas of contact. Issues related to the numbers and training of medical personnel that move with combat forces must be considered.

Classes of Casualties. The question of the number of casualties to be expected has been dealt with above. In this section, the question to be addressed involves the kinds of casualties that the management system must expect to deal with. These are:

Conventional. The conventional mix of combat related trauma associated with blast, penetrating missiles, and heat. The issue of whether or not significant quantitative increments in any of these factors are to be expected must be examined.

Nuclear/Chemical. If nuclear and/or chemical weapons are employed, the mix of casualties will change radically. Issues related to dose-graded radiation sickness must be dealt with in terms of the development of triage and evacuation doctrine. The threat of chemical attack can be expected to produce significant numbers of heat exhaustion casualties as well as ones produced by the inappropriate use of antidotes. Attention must also be paid to the high probability of serious infectious disease among troops experiencing immune system suppression following exposure to non-lethal doses of radiation.

Novel. New classes of casualties created by the employment of novel weapon systems must be expected. A prime candidate is the laser which can be expected to generate significant numbers of ophthamological wounds. The number of such wounds to be expected will depend upon whether injury is an inadvertent consequence of laser use in communications or target designation, or if the laser is also employed as a direct anti-personnel weapon.

Neuropsychiatric. Neuropsychiatric casualties are to be expected in large numbers. In addition to what might be termed the normal casualty load associated with high intensity, sustained combat, the intense fear associated with nuclear and chemical threat must be considered. The

introduction of novel weapons which produce new classes of casualty, against which there are no effective countermeasures, will introduce significant stressors that will alter psychiatric casualty rates. Significant numbers of psychiatric casualties may be expected to occur in rear areas as a result of the nature of the combat that may be expected to occur there.

Triage and Evacuation. Triage and evacuation doctrine have been mentioned above. The seriousness of the issues raised by the prospective battle field is such that separate consideration is merited. Manpower availability will be a critical factor during the middle phases of the prospective battle. The most readily available sources of manpower will be physical and psychiatric casualties who will be able to return to full or limited duty if they have been properly managed.

Research from World War II and the Korean War indicates that 80 to 90 percent of psychiatric casualties can be returned to combat if they receive treatment near to the battlefield. It is not clear that such treatment will be possible near the prospective battlefield. For example, concentrations of psychiatric casualties located in the vicinity of the Main Battle Area might alter the infrared signature of the area sufficiently to bring them under fire. If proximal treatment cannot be given and new treatment modalities are not developed, the proportion of individuals who can be returned to duty may drop precipitously. These issues must be explored vigorously.

The Role of Women on the Prospective Battlefield

The physical and psychophysiological questions related to the role of women on the prospective battlefield may be translated into a set of specific questions concerning the existence of significant differences between male and female response to battlefield conditions.

Response to Military Stress. It must be determined whether or not there are there fundamental and militarily significant differences in the female physical and psychological responses to the manifold stresses of the battlefield. Similarly, it must be determined whether or not

there are significant differences in the capacity of women to sustain effective military performance over the extended opera tional periods that will be required in future warfare. These questions carry no implication that women cannot perform well on most military tasks. However, men are likely to possess clear sustainability advantages in performing those tasks that involve heavy physical work. Such tasks comprise a relatively small proportion of the total range of activities needed on or near the contemporary battlefield. The specific issue being raised relates to the possibility of significant differential casualty generation rates between men and women exposed to similar battle field conditions. At present, there is no really convincing body of scientific data which permit either the extent or direction of any sex-related casualty rate differences to be firmly determined.

Male Response to Females at Risk. It must be determined if the presence of women in situations of actual and potential threat will alter the behavior of their male counterparts in a militarily significant ways. This issue concerns male belief and value systems that are common to western societies and which place differential value on the safety of women in situations of risk. It is a strongly held military value that all good soldiers give aid and comfort tc their fallen comrades, often at considerable risk to themselves. We do not clearly understand how this value, and others like it, will be transformed when many of those comrades are women.

Management of Female Casualties. It must be determined whether or not women will represent special casualty management problems. A significant part of this question is related to the issue raised above concerning the impact of social value systems on male behavior. Triage and evacuation doctrines are critical medical elements in the achie vement of force conservation. The possibility of subversion of these doctrines through decisions based on the application of well-meaning but inappropriate value systems must be examined. Anatomical and physiological sex-based differences may impact on the delivery of medical care in cases of traumatic injury. For example, abdominal wounds in female soldiers are likely to be accompanied by the added complications associated with injuries to the reproductive system. Good combat wound management that is conducted under the pressures generated by battle often involves extensive removal of damaged tissue, a procedure that is likely to have cosmetic consequences. The impact of such disfigurement may require the development of

special psychiatric support modalities.

Pharmacological Support of Performance

The central problem with all of the contemporary pharmacological agents that are of interest is their broad spectrum of action. Desirable effects are accompanied inevitably by undesirable side effects that limit the range of practical application. For example, a compound that is both prophylactically effective against Soman and also physically and/or psychologically incapacitates the recipient is of dubious military value. Creating casualties of one kind in order to avoid casualties of another kind is an unproductive undertaking. Amphetamine, and related compounds may be effective in sustaining certain simple behaviors under conditions of fatigue, but the quality of complex performances will deteriorate under the drug if inhibition of response is an important behavioral component. Among all of the areas included under the rubric of the neurosciences, the disciplines associated with neurochemistry are undergoing the most explosive development. Our general understanding of central and peripheral nervous system functioning is now clearly dependent upon our understanding of the biochemical events that create and modulate activity in the area of the synapse. These events are the targets of the weapons that define the chemical threat to the integrity of our forces. Our basic understanding of neurochemistry will be the source of effective countermeasures that can be developed. The pressing need over the next twenty years is for broad-based, fundamental research in the biology of nervous function. This effort is also critical to the development of effective pharmacological supports for military function.

Chemical Attack. The development of prophylactic agents that are both effective against chemical attack and not in themselves disabling is a high priority requirement. Insufficient attention has been paid to the psychological aspects related to the threat of chemical attack. This threat can be viewed as psychological warfare which from the enemy point of view could have impacts that justify the cost of making the threat credible. These impacts range from causing our forces to suit up in protective gear, through self-administration of incapacitating antidote, to outright panic in areas perceived to be

threatened. The donning of protective gear in and of itself will significantly limit mobility, limit perceptual fields and communication, increase isolation, and significantly reduce performance sustainability. The availability of effective, non-incapacitating prophylactic and therapeutic agents would effectively disarm the chemical threat by reducing a significant anxiety and fear provoking stressor.

Nuclear Attack. The development of prophylactic and treatment agents that are effective against critical levels of exposure to radiation is a high priority requirement. Critical radiation dosages are in the intermediate range and should be defined in terms of the direct generation of casualties over days and weeks and to infectious disease casualties that arise as a result of radiation-induced immune suppression. Such casualties would represent a significant proportion of a fighting force exposed to tactical nuclear attack.

Acute Situational Stress Syndrome. The development of prophylactic and therapeutic agents that will effectively modify the acute situational stress syndrome is required. Contemporary families of psychotherapeutic drugs have a variety of side effects that will limit their effectiveness on the prospective battlefield. The critical issue here is achieving reduction of incapacitating fear and anxiety while simultaneously establishing and maintaining essential mobility and self-care behaviors.

Fatigue and Sleep Control. The development of prophylactic agents that will modulate the accumulation of physical and psychological fatigue, or modify the need for sleep, or the patterning of sleep under battlefield conditions are required. Again, the critical issue is the maintenance of essential performance capabilities.

There are persistent reports of botanicals that possess "adaptogenic" properties. Such properties are claimed to manifest themselves in increased resistance to the impact of a variety of stressors and thus to operate prophylactically. Other recent work suggesting that the availability and balance of certain large neutral amino acids can modulate arousal may point to the development of new classes of pharmacological agent that are benign with respect to side effects. In the case of sleep modulating agents, the central performance questions involve ease of awakening and alerting as well as the speed of return to

full performance capability.

Performance Enhancement. The topics dealt with up to this point have been concerned with the maintenance of pre-existing performance capacities and the prevention of untoward consequences associated with a variety of environmental and situational insults. In accordance with the time frame of this study, it can be speculated that the fundamental research directed at the issues raised will lead to the development of performance enhancing drugs. Such drugs would increase physical and/or psychological capacities beyond what would be expected in their absence. Memory, vigilance, the ability to sustain and divide attention, and complex reaction times are militarily important psychological functions that are likely candidates for enhancement. The development of such agents would have widespread implications for training as well as for combat.

Drug Interactions. Potential success in more than one of the areas outlined above raises the issue of drug interactions through synergy and/or antagonism. It is highly unlikely that a mix of pharmacological agents that is distributed to troops for their personal use on the battlefield will be subject to effective management or control. It is also unlikely that medical resources capable of directing the administration of appropriate drug doses and combinations will be prevalent. All possible interactions that are inherent in such a pharmacopoeia must be understood prior to its dispersion to troops. Issues related to the preparation of drug compounds and the development of novel routes of administration must be addressed.

A second set of issues involves the abuse potential of such classes of drugs. The types of pharmacological support that have been discussed will in all likelihood operate through central and autonomic nervous system mechanisms. They all can be classified as substances that reduce the aversiveness of environmental events, or create internal states that might be construed as being positive. Such compounds are excellent candidates for becoming abused substances. It seems unlikely that the quest for mind-altering substances will lessen significantly among the young populations from which the preponderance of forces are drawn.

CONCLUSIONS AND RECOMMENDATIONS

Leadership and Command

Leadership and command functions will be particularly susceptible to the stresses and strains that are an inherent part of the integrated, sustained battlefield. The nature of these stressors must be explicitly recognized and ameliorative procedures must be made an explicit part of the preparation, training, and evaluation of this critical group of soldiers. See Leadership and Command (p. 10).

Distribution of Performance Loads

Intense fatigue will be a critical factor affecting performance sustainability in all military organizations and at all levels within organizations. The distribution of work and rest, in coordination with the contingencies generated by battlefield situations and the availablility of personnel, is a critical issue in the management and control of human resources. No single work/rest doctrine, appropriate for the entire range of expected conditions, can be recommended. An empirical and pragmatic approach, closely coupled with intensive training for sustained operations is suggested. See Leadership and the Control of Fatigue (p. 11).

Unit Reconstitution

Force attrition on the integrated, sustained battlefield is expected to be very high and replacements are expected to be very scarce. The survivors of fragmented units, the lightly wounded, returning neuropsychiatric casualties, and levies from support units are suggested sources of replacements. The nature of the battle will dictate that these diverse elements be hastily amalgamated into new, reconstituted units. The doctrine and underlying principles that are required to accomplish this goal must be developed. See Unit Reconstitution (p.20).

Casualty Management

The integrated, sustained battlefield is expected to produce large numbers of casualties whose types and geographical distributions will differ from previous military experience. Further, the nature of the battlefield will significantly alter the nature and locus of medical intervention, the procedures for and realities of evacuation, and the appropriateness of triage doctrine. Since factors related to casualty management have important implications for both force conservation and force morale, it is suggested that these problems be given immediate consideration. See Casualty Management (p. 21).

Role of Women

Women will constitute a significant proportion of the U.S. troops fielded in response to a main force attack on NATO. These female troops will be members of rear and forward support units. They will be distributed in both traditional and non-traditional military occupational roles, with many of the latter being found in critical maintenance and electronic warfare areas. While not occupying direct combat roles, female troops will be exposed to unprecedented levels of risk as a consequence of the nature of the prospective battlefield. Barring exposure to the levels of physical demand that have been the traditional lot of the infantryman, there is little biological reason to believe that women will withstand the multiple stressors of combat exposure any less well than will men. However, there is reason to believe that men will respond differently to the presence of women at risk in the combat environment. Powerful cultural conditioning, common to western societies, must be overcome before male soldiers will treat with their female compatriots as equals and be affected by their wounding or death without sexual distinction.

Pharmacological Support

Recent advances in understanding the biochemistry of central and peripheral nervous system functioning promise significant development of pharmacological supports for military performance. However, a strong caveat concerning the use of drugs on and near the battlefield must be entered. In order to fight well and survive, the soldier must function as an integrated biological organism. Issues related to drug specificity of action, dosage tolerance, abuse potential, and drug interactions must be fully evaluated against operational requirements. In addition to pharmacological intervention to reduce fatigue, anxiety and fear, chemical defense protective agents will be developed and deployed. It is critical that the behavioral consequences of the use of such agents be well understood.

RESEARCH REQUIREMENTS

Mental Fatigue

It is imperative that our scientific understanding of the basic biological processes involved in the generation of mental fatigue states be understood. A program of research in this area would include the delineation of the peripheral and central biochemical concomitants of mental fatigue. The goal of this program would be the development of prophylactic and therapeutic intervention strategies to improve performance sustainability.

Sleep Discipline

Research concerned with the biological basis of sleep must be accelerated. Particular attention must be paid to the role of fragmentary sleep (of varying duration, taken at odd hours, under adverse conditions, etc.) in the maintenance of performance capability. Of particular interest are higher level cognitive behaviors that must be accomplished in multiple demand situations. While sleep

deprivation and fatigue often accompany one another, there is strong scientific reason to believe that separable processes are involved. Research that clarifies the distinctions between these processes will have important practical applications. The goal of this program would be the development of effective sleep/rest discipline for use on the battlefield.

Modulation of Autonomic Functions

Research concerned with the voluntary modulation of autonomic functions to ameliorate the acute situational stressors associated with sustained combat should be extended. The symptoms associated with intense fear and anxiety themselves play an important role in determining performance capability. The symptoms associated with exposure to nerve agent are very like those that accompany the autonomic arousal produced by battlefield stresses. Increasing the individual soldier's capacity to interpret and control internal states appears to be an achievable and practical possibility. The goals of this program would be to reduce the rate of neuropsychiatric casualty generation and to increase performance sustainability.

Shiftwork

The required research program should be directed toward the analysis of the performance requirements of forward and rear support organizations. Based on the outcomes of these analyses and the existing shiftwork literature, candidate schedules should be proposed. Candidate schedules should then be further screened be analyzed in terms of manpower feasibility. Surviving schedules should then be utilized in extensive field studies during training and maneuvers to determine their adequacy for sustaining effective performance for prescribed periods of time. This testing process would probably require several iterations before final recommendations can be made. If carefully done, participating troops will receive valuable training in sustained operations.

Group Dynamics of Unit Reconstitution

An historical and scientific review of the principles underlying the creation of effective small groups under high demand and high stress conditions should be made. These principles should then be used to develop strategies for unit reconstitutions that can be tested in training and maneuver situations. Attention should be focused on the squad and the team as the fundamental unit of military social organization.

Forward Treatment of Physical Casualties

Topics for research under this heading are dictated by the exigencies of the highly mobile and widely distributed battlefield and the central role to be played by medical paraprofessionals and buddy-aid. The primary management of shock and trauma, radiation and chemical agent exposure, and secondary infectious disease will become the province of the medical corpsmen. They must be supplied with the necessary supporting technology.

Forward Treatment of Neuropsychiatric Casualties

Research in this area must center on the development of brief intervention strategies that rely on psychopharmacological supports. The exigencies of the battlefield will likely prevent the direct use of the successful treatment modalities developed during earlier wars. Fertile ground for revising earlier treatment doctrines may be found in conjunction with the development of principles appropriate for unit reconstitution.

Role of Women

Research on female soldier should focus on the adapta-

tion of women to military occupational roles and on the evolution of military organizations attempting to integrate increasing numbers of women into operationally critical positions. As suggested earlier, attention must be equally directed at the individual and social dynamics such positions. In the broad areas of biomedical and psychological research, female research subjects should be employed as a matter of course in all relevant work conducted under military auspices. The emphasis in such work should be placed on increasing our understanding of sex-related differences in psychobiological functioning rather than upon the testing of hypotheses related to suitability or unsuitability.

Pharmacological Supports

The basic requirement is for broad-based programs of fundamental research in the neurosciences. Our understanding of the biochemical bases of nervous system action is undergoing explosive development that has revolutionary implications for the creation of new classes of pharmacological agents. It is recommended that the development of pharmacological supports be based upon the rational scientific understanding of the biological principles that control and modulate nervous system activity. Particular attention should be paid to the biochemistry of synaptic events and the relationships between these events and functions, and emitted behavior.

There is a particular need for the development of sophisticated technological systems that enable and support the in vivo determination of neurochemical parameters and their correlation with ongoing electrophysiological and behavioral events. Such systems will ultimately depend upon the development of microminiature transducer arrays capable of differential response to molecular configurations. Intermediate technological steps will probably involve implantable sampling systems that are coupled to "on-line" analyzers that have extreme sensitivity. Since such work will probably be limited to animal models in the foreseeable future, parallel advances in the precision of behavioral models must also be encouraged.

REFERENCES

This reference list is not exhaustive. The listed titles have been found useful in providing the substantive background for the views presented in this report. We hope that it will provide a useful bibliography for other interested readers.

Aakvaag, A., Fonnum, F., & Opstad, P.K. Hormonal Changes in Serum in Young Officer Cadets During Prolonged Military Activities. 1978. In: Proceedings of the First RSG4 Physical Fitness Symposium with Special Reference to Military Forces. NATO DS/DR (78)98 pp 107-114.

Aakvaag, A., Sand, T., Opstad, P.K., & Fonnum, F. Hormonal Changes in Serum in Young Men During Prolonged Physical Strain. 1978. European Journal of Applied Physiology. 39:283-291.

Adams, O.S. & Chiles, W.D. Human Performance as a Function of the Work-Rest Cycle. March 1960. WADD TR 60-248, AD 240-654. Wright-Patterson Air Force Base, Ohio: Behavioral Sciences Laboratory.

Adamson, G.L. Fatigue. Aviation Medicine. 1952. 23:584-588.

Adan, A. On the Banks of the Suez. 1979. Edanim. Jerusalem, Israel.

Ahrenfeldt, R.H. Psychiatry in the British Army in the Second World War. 1958. Routledge & Kegan Paul.

Ainsworth, L.L., & Bishop, H.P. The Effect of a 48 Hour Period of Sustained Field Activity on Tank Crew Performance. 1971. HumRRO Technical Report 71-16.

Akerstedt, T., & Gillberg, M. Effect of Sleep Deprivation on Memory and Sleep Latencies in Connection with Repeated Awakenings from Sleep. 1979. Psychophysiology. 16:49-52.

Allan, J.R. & MacMillan, A.L. The Immediate Effects of Heat on Unacclimatized Paratroops (Exercise "Tiger Brew II"). 1962. Army Operations Research Establishment Research Memo No. 16/62.

Allen, C.L., Myles, W.S., MacNamara, W.D., & Nelson, P.D. Research Methodologies: Sustained Performance in Continuous Operations. 1974. In the Technical Cooperation Program,

Subgroup U, Action Group U-1, Human Performance and Military Capability in Continuous Operations, Final Report.

Aschoff, J., Giedke, H., Poppel, E., & Wever, R. The Influence of Sleep-interruption and of Sleep-deprivation on Circadian Rhythms in Human Performance. 1972. In: W.P. Colquhoun (Ed.), Aspects of Human Efficiency. The English Universities Press, Ltd., London, U.K. 135-150.

Alluisi, E.A. Sustained Performance. In Bilodeau, E.A., ed. Principles of Skill Acquisition. 1969. Academic Press. New York, N.Y. 59-101.

Astroshkin, N.T. Hygiene and Physiology of Military Labor. 1979. Moscow Voyenno-Meditsinskiy Zharnal. 8:45-47. Translated UDC.612.766.1-057:623,611.696.7:007

Baevskii, R.M., Berezina, G.A., Dushkov, B.A., Kosmolinskii, F.P., Kudriavtseva, V.I., Semenova, T.D., & Cherniaeva, S.A. Investigation of the Performance of the Man-Operator During 64- Hour Continuous Work. 1971. Aerospace Medicine. 42:1:105.

Bandura, A. Aggression, a Social Learning Analysis. 1973. Prentice-Hall. Englewood Cliffs, New Jersey.

Banks, J.H., Sternberg, J.J., Farrell, J.P., Debow, C.H., & Dalhamer, W.A. Effects of Continuous Military Operations on Selected Military Tasks. 1970. Behavior and Systems Research Laboratory, Office of Research and Development. Washington, D.C. U.S. Army Behavioral and Systems Research Laboratory Technical Report 1166.

Bartemeier, L.H., et. al. Combat Exhaustion. 1946. Journal of Nervous and Mental Disease. Vol 104.

Bartlett, F.C. Psychology and the Soldier. 1927. University Press. Cambridge, U.K.

Bartlett, F.C. Fatigue Following Highly Skilled Work. Proceedings of the Royal Society of London. Series B. Biological Sciences. 1941. 131:247-257.

Basowitz, H., Persky, H., et.al. Anxiety and Stress. 1955. McGraw Hill. New York, N.Y.

Batson, C.D., Pote, S., et.al. Helping Under Conditions of Common Threat: Increased "We Feeling" or Ensuring Reciprocity. Social Psychology Quarterly. 1979. 42:410-414.

Baynes, J. Morale. 1967. Cassel. London, U.K.

Beebe, G.W., & de Bakey, M.E. Battle Casualties. 1952. C.C. Thomas, Springfield Ill.

Beatty, J.K., & Hales, J.A. The Infantry Platoon Leader. Infantry. 1978. 68:22-27.

Berkun, M.M., Bailek, H.M., et. al. Experimental Studies of Psychological Stress in Man. Psychological Monographs. 1962. 79:No. 534.

Bertelson, A.D. Effects of Napping and Bedrest on Performance and Mood. 1979. Unpublished Doctoral Thesis, Ohio State University.

Betit, E.D. Soviet Training for Night Warfare. Military Review. 1975. September:81-85.

Bidwell, S. Modern Warfare. 1973. Allen Lane. London, U.K.

Bink, B. The Physical Working Capacity in Relation to Working Time and Age. Ergonomics. 1962. 5:25-28.

Blumenson, M. & Stokesbury, J.L. Masters of the Art of Command. 1975. Houghton Mifflin Co. Boston, Massachusetts.

Bohlin, C., & Kjellberg, A. Self-reported Arousal During Sleep Deprivation and its Relation to Performance and Physiological Variables. 1973. Scandinavian Journal of Psychology. 14:78-86.

Bonnet, M.H. Sleep, Performance, and Mood after the Energy-expenditure Equivalent of 40 Hours of Sleep Deprivation. 1980. Psychophysiology. 17:1:56-63.

Bourne, P.G. Men, Stress and Vietnam. 1970. Little. Boston, U.S.

Bowman, D.C. Combat Stress. Infantry. 1973. 63:40-47.

Bramson, L., & Goethals, G.W., eds. War. 1964. Basic Books. New York, N.Y.

Broadbent, D.E. Perception and Communication. 1958. Pergamon. Oxford, U.K.

Broadbent, D.E. Decision and Stress. 1971. Academic Press. New York, N.Y.

Brodan, V., & Kuhn, E. Physical Performance in Man During Sleep Deprivation. 1967. Journal Sports Medicine Phys. Fit. 7:28-30.

Bugge, J.F., Opstad, P.K., & Magnus, P.M. Changes in the Circadian Rhythm of Performance and Mood in Healthy Young Men Exposed to Prolonged, Heavy Physical Work, Sleep Deprivation, and Caloric Deprivation. 1979. Aviat. Space Environ. Med. 50:5:663- 668.

Cameron, C. Fatigue Problems in Modern Industry. Ergonomics. 1971. 14:713-720.

Cameron, C. A Theory of Fatigue. Ergonomics. 1973. 16:633- 648.

Carskadon, M.A., & Dement, W.C. Sleep Studies on a 90-Minute Day. 1975. Electroencephalography and Clinical Neurophysiology. 39: 145-155.

Cavemar, J.O., Jr., & Nash, J.L. The Effects of Combat and the Normal Personality: War Neurosis in Vietnam Returnees. Comprehensive Psychiatry. 1976. 17:647-653.

Clements, P.R., Hafer, M.D., & Vermillion, M.E. Psychometric, Diurnal, and Electrophysiological Correlates of Activation. 1976. Journal of Personality and Social Psychology. 33:387-394.

Collins, W.E. Some Effects of Sleep Deprivation on Tracking Performance in Static and Dynamic Environments. Journal of Applied Psychology. 1977. 62:567-573.

Clum, G.A., & Hoiberg, A. Diagnosis as Moderators of the Relationship Between Biographical Variables and Psychiatric Decision in a Combat Zone. Journal of Consulting and Clinical Psychology. 1971. 47:209-214.

Clum, G.A., & Mahan, J.L. Jr. Attitudes Predictive of Marine Combat Effectiveness. Journal of Social Psychology. 1971. 83:55-62.

Cockerham, W.C. Attitudes Toward Combat Among U.S. Army Paratroopers. Journal of Political and Military Sociology. 1978. 6:1-15.

Colquhoun, W.P. Circadian Variations in Mental

Efficiency. 1971. In: W.P. Colquhoun (Ed.), Biological Rhythms and Human Performance. Academic Press, London, U.K. 39-108.

Colquhoun, W.P., Blake, M.J.F., & Edwards, R.S. Experimental Studies of Shift-work. II. Stabilized 8-hour Shift Systems. Ergonomics. 1968. 11:527-556.

Colquhoun, W.P., Blake, M.J.F., & Edwards, R.S. Experimental Studies of Shift-work. III. Stabilized 12-hour Shift Systems. Ergonomics. 1969. 12:865-882.

Colquhoun, W.P., Folkhar, S., et. al. Experimental Studies of Shiftwork. 1975. Westdeutcher Verlag. Oplander, F.R.G.

Conrad, R. Speed and Load Stress in a Sensori-motor Skill. British Journal of Industrial Medicine. 1951. 8:1-7.

Cummings, T.G., & Cooper, C.L. A Cybernetic Framework for Studying Occupational Stress. Human Relations. 1979. 32:395- 418.

Curtis, G.C., & Fogel, M.L. Random Living Schedule: Psychological Effects in Man. 1972. Journal of Psychiatric Research. 9:315-323.

Davey, C.P. Physical Exercise and Mental Performance. Ergonomics. 1973. 16:595-599.

Davies, C.T.M., & Thompson, M.W. Estimated Aerobic Performance and Energy Cost of Severe Exercise of 24 H Duration. 1979. Ergonomics. 22:11:1249-1255.

Davis, S.W. Stress in Combat. Scientific American. 1956. 194:31-35. Dawkins, C.T. Night Operations for Infantry. 1914. Gale & Polden, Ltd. London, U.K.

Dearnaley, E.J. & Warr, P.B., eds. Aircrew Stress in Wartime Operations. 1979. Academic Press. London, U.K.

Dement, W.C. Sleep Deprivation and the Organization of the Behavioral States. 1972. In: C. Clements, D. Purpura, & F. Mayer (Eds). Sleep and the Maturing Nervous System. Academic Press. New York, N.Y. 319-361.

Dinges, D.F., Orne, E.C., Evans, F.J., & Orne, M.T. Performance after Naps in Sleep-conducive and Alerting Environments. 1981. In: L.C. Johnson, D.I. Tepas,

W.P. Colquhoun, & M.J. Colligan (Eds.) The 24-hour Workday: A symposium on Variations in Work- Sleep Schedules. National Institute for Occupational Safety and Health. Washington, D.C. In Press.

Drucker, E.H., Canon, L.D., & Ware, J.R. The Effects of Sleep Deprivation on Performance over a 48-Hour Period. 1969. HumRRO Technical Report Number 69-8.

Dunlop, W.A.S. The Fighting Soldier. 1940. Heinemann Dupuy, T.N. A Genius for War. 1977. MacDonald and Jane's. London, U.K.

Ellis, J. The Sharp End. 1980. Charles Scribner's Sons, New York, N.Y.

Emanski, Jr., J.J. Continuous Land Combat. (SRI Project 4940) 1977. SRI International. Menlo Park, California.

Evans, F.J. Subjective Characteristics of Sleep Efficiency. 1977. Journal of Abnormal Psychology. 86:561-564.

Evans, F.J., Cook, M.R., Cohen, H.D., Orne, E.C., & Orne, M.T. Appetitive and Replacement Naps: EEG and Behavior. 1977. Science. 197:687-689.

Evans, F.J., Orne, M.T. Recovery from Fatigue. 1975. U.S. Army Medical Research and Development Command. Washington, D.C. (Final Report on Contract No. DADA 17-71-C-1120).

Feinberg, I., & Carlson, V.R. Sleep Variables as a Function of Age in Man. 1968. Arch. gen. Psychiat. 18:239-250.

Fiedler, F.E. A Theory of Leadership Effectiveness. 1967.
McGraw-Hill. New York, N.Y.

Fort, A., & Mills, J.N. Influence of Sleep, Lack of Sleep and Circadian Rhythm on Short Psychometric Tests. 1972. In: W.P. Colquhoun (Ed). Aspects of Human Efficiency. English Universities Press. London, U.K. 115-127.

Francesconi, R.P., Stokes, J.W., Banderet, L.E., & Kowal, D.M. Sustained Operations and Sleep Deprivation: Effects on Indices of Stress. 1978. Aviation, Space, and Environmental Medicine 49:1271-1274.

Ginzberg, E., et. al. The Ineffective Soldier (Vols I, II, III). 1959. Columbia University Press, New York, N.Y.

Glass, A.J. Principles of Combat Psychiatry. Milit. Med. 1955. 117:27.

Glass, A.J. & Bernucci, R.J. Neuropsychiatry in World War II: Vol. I. 1968. Office of the Surgeon General, Dept. of the Army, Washington, D.C.

Grandjean, E.P. Fatigue: Its Phsiological and Psychological Significance. Ergonomics. 1968. 11:427-436.

Greenbaum, C.W. The Small Group Under the Gun -- Uses of Small Groups in Battle Conditions. Journal of Applied Behavioral Science. 1979. 15:392-405.

Griffin, S.J., & Trinder, J. Physical Fitness, Exercise and Human Sleep. 1978. Psychophysiology. 15:447-450.

Haggard, D.F. HumRRO Studies in Continuous Operations. 1970. Human Resources Research Organization. Washington, D.C. HumRRO Professional Paper Number 7-70, AD 705-705.

Hale, H.B., Hartman, B.O., Harris, D.A., Miranda, R.E., & Williams, E.W. Physiologic Cost of Prolonged Double-crew Flights in C-5 Aircraft. 1973. Aerospace Medicine. 44:999-1008.

Hamilton, R., Wilkinson, R.T., & Edwards, R.S. A Study of Four Days Partial Sleep Deprivation. 1972. In: W.P. Colquhoun (Ed.), Aspects of Human Efficiency. English Universities Press. London, U.K. 101-113.

Hammel, E.M., & Lane, J.E. 76 Hours: The Invasion of Tarawa. 1980. Belmont Tower Books. New York, N.Y.

Hammerton, M., & Tickner, A.H. Physical Fitness and Skilled Work after Exercise. Ergonomics. 1968. 11:41-45.

Hammerton, M., & Tickner, A.H. An investigation in the Effects of Stress upon Skilled Performance. Ergonomics. 1969. 12:851- 855.

Hare, A.P. Handbook of Small Group Research. 1976. Free Press of Glencoe.

Harris, D.A., Pegram, G.V., & Hartman, B.O. Performance and Fatigue in Experimental Double-crew Missions. 1971.

Aerospace Medicine. 42:980-986.

Harris, F.G., Mayer, J., & Becker, H.A. Experiences in the Study of Combat in the Korean Theater: I. Psychiatric and Psychological Data. 1955. Walter Reed Army Institute of Research. Washington, D.C.

Harris, W. Mackie, R.R., & Wilson, C.L. Performance Under Stress: A Review and Critique of Recent Studies. 1956. Human Factors Research, Inc.

Harris, W. & O'Hanlon, J.F. A Study of Recovery Functions in Man. 1972. U.S.A. Human Engineering Laboratories. Aberdeen Proving Ground, Md. TR No. HEL TM 10-72.

Hartley, L., & Shirley, E. Sleep-loss, Noise and Decisions. Ergonomics. 1977. 20:481-489.

Hartley, L.R. A Comparison of Continuous and Distributed Reduced Sleep Schedules. 1974. Quarterly Journal of Experimental Psychology. 26:8-14.

Hartmann, E.L. The Functions of Sleep. 1973. Yale University Press. New Haven, Conn.

Haslam, D.R. The Effect of Continuous Operations upon the Military Performance of the Infantryman (Exercise "Early Call" II). 1978. Army Personnel Research Establishment. Farnsborough, U.K. APRE Report No. 4/78.

Haslam, D.R., Allnutt, M.F., et. al. The Effect of Continuous Operations upon the Military Performance of the Infantryman (Exercise "Early Call" I). 1977. Army Personnel Research Establishment. Farnborough, U.K. APRE Report No. 2/77.

Hicken, V. The American Fighting Man. 1969. The Macmillan Company. New York, N.Y.

Hockey, G.J.R. Changes in Attention Allocation in a Multicomponent Task Under Loss of Sleep. Brit. J. Psychol. 1970. 61:473-480.

Hodge, D.C., ed. Military Requirements for Research on Continuous Operations. 1972. Aberdeen Research and Development Center. Aberdeen, Maryland.

Hughes, A.F., & Goldman, R.F. Energy Cost of "Hard Work." 1970. Journal of Applied Physiology. 29:570-572.

Holland, G.J. The Effects of Limited Sleep Deprivation on the Performance of Selected Motor Tasks. 1966. Dissert. Abstracts. 27(4-A):940-941.

Jackson, W.G.F. The Battle for Rome. 1969. Charter Books. New York, N.Y.

Janowitz, M. Military Elites and the Study of War. Journal of Conflict Resolution. 1957. 1:9-18.

Johnson, L.C. Sleep Loss and Sleep Deprivation as an Operational Problem. 1974. U.S.N. Health Research Center. San Diego, California. TR No. 74-45. AD A015-640.

Johnson, L.C. & Naitoh, P. The Operational Consequences of Sleep Deprivation and Sleep Deficit. 1974. Technical Editing and Reproduction Ltd. NATO/AGARDograph No. 193.

Keegan, J., The Face of Battle. 1976. The Viking Press. New York, N.Y.

Klein, K.E, and Wegmann, H.M. Significance of Circadian Rhythms in Aerospace Operations. 1980. NATO/AGARDograph No. 247.

Knauth, P., Rohmert, W., & Rutenfranz, J. Systematic Selection of Shift Plans for Continuous Production with the Aid of Work- physiological Criteria. 1979. Applied Ergonomics. 10:9-15.

Kopstein, F.F., Siegel, A.I., et. al. Human Performance in Continuous Operations: Vol. II. Management Guide. 1979. U.S. Army Research Institute for the Behavioral Sciences. Arlington, Virginia. Res. Prod. 80-4b.

Krueger, G.P., & Fagg, J.N. Aeromedical Factors in Aviator Fatigue, Crew Work/Rest Schedules and Extended Flight Operations: An Annotated Bibliography. January, 1981. USAARL Report No. 81- 1. U.S.A. Aeromedical Research Laboratory, Fort Rucker, Alabama.

Larsen, L.A., ed. Fitness, Health, and Work Capacity. 1974. MacMillan. New York, N.Y.

Lazarus, R.S. Psychological Stress and the Coping Process. 1966. McGraw Hill. New York, N.Y.

Levav, H., & Baruch, E. Psychiatric Combat Reactions During the Yom Kippur War. American Journal of

Psychiatry. 1979. 136:637- 641.

Little, R.W. Buddy Relations and Combat Performance. In: Janowitz, M., ed. The New Military. 1964. Russel Sage Foundation. New York, N.Y.

Lubin, A., Hord, D.J., Tracy, M.L., & Johnson, L.C. Effects of Exercise, Bedrest and Napping on Performance Decrement During 40 Hours. 1976. Psychophysiology. 13:4:334.

Mackie, R.R., ed. Vigilance: Theory, Operational Performance, and Physiological Correlates. 1977. Plenum Press. New York, N.Y. and London, U.K.

Mahan, J.L., & Clum, G.A. Longitutudinal Prediction of Marine Combat Effectiveness. Journal of Social Psychology. 1971. 83:45-54.

Manning, F.J. Continuous Operations in Europe: Feasibility and the Effects of Leadership and Training. 1981. Parameters, Journal of the US Army War College. IX:3, 8-17.

Marshall, S.L.A. Men Against Fire. 1947. William Morrow. New York, N.Y.

Marshall, S.L.A. Sinai Victory. 1958. William Morrow and Company. New York, N.Y.

Marshall, S.L.A. Night Drop. 1962. Macmillan, New York, N.Y.

Marshall, S.L.A. The Soldier as a Leader. 1966. Stockpole Books. Harrisburg, Pennsylvania.

Mauldin, B. Up Front. 1945. Henry Holt and Company. New York, N.Y.

Merbaum, M. Some Personality Characteristics of Soldiers Exposed to Extreme War Stress: A Follow-up Study of Post-hospital Adjustment. Journal of Clinical Psychology. 1977. 33:558-562.

Monjan, A.A., & Collector, M.E. Stress-induced Modulation of the Immune Response. 1977. Science. 196:307-308.

Morgan, B.B. Jr Effects of Continuous Work and Sleep Loss in the Reduction and Recovery of Work Efficiency. American Industrial Hygiene Association Journal. 1974. 35:13-20.

Morgan, B.B. Jr., Brown, B.R., & Alluisi, E.A. Effects on Sustained Performance of 48 Hours Continuous Work and Sleep Loss. 1974. Human Factors. 16:406-414.

Morgan, B.B. Jr, Winne, P.S., & Dungan, J. The Range and Consistency of Individual Differences in Continuous Work. 1980. Human Factors. 22:331-340.

Moses, J.M., Hord, D.J., Lubin, A., Johnson, L.C., & Naitoh, P. Dynamics of Nap Sleep During a 40-Hour Period. 1975. Electroencephalography Clinical Neurophysiology. 39:6:627-633.

Moskos, C.C. The American Enlisted Man. 1970. Russell Sage Foundation, New York, N.Y.

Muller, E.A. Occupational Work Capacity. Ergonomics. 1962. 5:445-452.

Myles, S., Echlache, J.P., & Beaury, J. Self-pacing During Sustained Repetitive Exercise. 1979. Aviat. Space Environ. Med. 50:921-924.

Naitoh, P. & Townsend, R.E. The Role of Sleep Deprivation Research in Human Factors. Human Factors. 1970. 12:575-585.

North Atlantic Treaty Organization. Study of Fighting Under Conditions of Limited Visibility (U). October, 1971. NATO AC/243-D/143, AC (Panel 1), D/26. NATO CONFIDENTIAL.

Olley, R., & Krauss, H.H. Variables Which May Influence the Decision to Fire in Combat. Journal of Social Psychology. 1974. 92:151-152.

Opstad, P.K., & Aakvaag, A. The Effect of a High Calory Diet on Hormonal Changes in Young Men During Prolonged Physical Strain and Sleep Deprivation. 1981. European Journal of Applied Physiology. 46:31-39.

Opstad, P.K., Aakvaag, A., & Rognum, T.O. Altered Hormonal Response to Short-term Bicycle Exercise in Young Men After Prolonged Physical Strain, Caloric Deficit, and Sleep Deprivation. 1980. European Journal of Applied Physiology. 45:51-62.

Opstad, P.K., Ekanger, R., Nummestad, M., & Raabe, N. Performance, Mood and Clinical Symptoms in Men Exposed to

Prolonged, Severe Physical Work and Sleep Deprivation. 1978. Aviation, Space and Environmental Medicine. 49:1065-1073.

Pace, N., et.al. Physiological Studies on Infantrymen in Combat. 1956. U. of California Press. Berkely, California.

Page, M.M., Goff, C., & Palmer, J.D. The Psychological Effects of Non Nuclear Weapons: A Bibliography with Selected Abstracts. Report 1419-4 (Volume 1) Oklahoma University. 1964.

Perelli, L.P. Effects of Fatigue Stressors on Flying Performance, Information Processing, Subjective Fatigue, and Physiological Cost Indices During Simulated Long-Duration Flight. 1980. Ph.D. Dissertation. The Catholic University of America. Washington, D.C.

Pfieffer, M.G., Siegel, A.I., et. al. Background Data for the Human Performance in Continuous Operations Guidelines. 1979. U.S. Army Research Institute for the Behavioral and Social Sciences. Arlington, Virginia. Tech Rep No 386.

Rioch, D. McK. Problems of Preventive Psychiatry in War. In Psychopathology of Children. 1955. Grune & Stratton. New York, N.Y. p 146.

Rose, A.M. Neuropsychiatric Breakdown in the Garrison Army and in Combat. American Sociological Review. 1956. 21:480-488.

Savkin, V. Ye., The Basic Principles of Operational Art and Tactics. 1971. Translation: U.S. Government Printing Office, Washington, D.C. Catalog Number D301.[illegible]9.4

Scheving, L., & Halberg, F., Chronobiology: Principles and Applications to Shifts in Schedules. 1980. Sijthoff & Noordhoff. Rockville, Md.

Schlosberg, A., & Benjamin, M. Sleep Patterns in Three Acute Combat Fatigue Cases. 1978. Journal of Clinical Psychiatry. 39:546-549.

Scott, H.F., & Scott, W.F. The Armed Forces of the USSR. 1979. Westview Press, Inc. Boulder, Colorado.

Shirom, A. On Some Correlates of Combat Performance. Administrative Science Quarterly. 1976. 21:419-432.

Siderenko, A. A., The Offensive. 1970. Translation: U.S. Government Printing Office, Washington, D.C. Catalog Number D301.79.1.

Siegel, A.I., Pfeiffer, F.F., et. al. Human Performance in Continuous Operations: Vol. I. Human Performance Guidelines. 1979. U.S. Army Research Institute for the Behavioral and Social Sciences. Alexandria, Virginia. Res. Prod. 80-4a.

Simonson, E., ed. Physiology of Work Capacity and Fatigue. 1971. C.C. Thomas. Springfield, Illinois.

Simonson, E. & Weiser, P.L., eds. Psychological Aspects and Physiological Correlates of Work and Fatigue. 1976. C.C. Thomas. Springfield, Illinois.

Sohlberg, S.C. Stress Experiences and Combat Fatigue During the Yom Kippur War (1973). Psychological Reports. 1973. 38:523- 529.

Soule, R.G., & Goldman, R.F. Pacing of Intermittant Work During 31 Hours. 1973. Med. Sci. Sports. 5:128-131.

Stouffer, S.A., et.al. The American Soldier, Combat and its Aftermath. 1949. Princeton University Press. Princeton, New Jersey.

Stoker, P.J. Psychological Stress in the Military Environment. April, 1977. Sciences 3(RAF). London, U.K. (Draft)

Swank, R., & Marchand, W. Combat Neuroses: the Development of Combat Exhaustion. 1946. Archives of Neurology and Psychiatry. Vol 55.

U.S. Department of the Army. Night Operations Conference, 29-31 July 1975. Oct 1975. ATSW-TA-1, U.S.A. Combined Arms Center and Fort Leavenworth. Fort Leavenworth, Kansas. U.S. Department of the Army. Concept Paper on Night Operations. August 1975. ACN:22722, U.S.A. Combined Arms Center, Fort Leavenworth, Kansas.

U.S. Department of the Army. Special Bibliographic Number 56: Night Operations. 1976. U.S. Command and General Staff College. Fort Leavenworth, Kansas.

U.S. Department of the Army. The Rifle Squads: Mechanized and Light Infantry. 1976. U.S. Army Adjutant General Publication Center. Baltimore, Maryland.

U.S. Department of the Army. The Mechanized Infantry Platoon and Squad. FM 7-7. 1977. U.S. Army Adjutant General Publication Center. Baltimore, Maryland.

U.S. Department of the Army. Operations of Army Forces. 1977. U.S. Army Adjutant General Publication Center. Baltimore, Maryland.

U.S. Department of the Army. The Tank and Mechanized Infantry Battalion Task Force. FM 71-2. 1977. U.S. Army Adjutant General Publication Center. Baltimore, Maryland.

U.S. Department of the Army. The Tank and Mechanized Infantry Company Team. FM 71-1. 1977. U.S. Army Adjutant General Publi- cation Center. Baltimore, Maryland.

Valentine, C.W. The Human Factor in the Army. 1954. Gale & Polden, Aldershot, England.

Webb, W.B., & Agnew, Jr. H.W. Effects on Performance of High and Low Energy-expenditure During Sleep Deprivation. 1973. Perceptual and Motor Skills, 37:511-514.

Webb, P., & Hiestand, M. Sleep Metabolism and Age. 1975. J. Appl. Physiol. 38:257-262.

Weinberg, S.K. The Combat Neuroses. 1946. American Journal of Sociology. Vol 51.

Weitzman, D.O., & Ozkaptan, H. A Survey of some Human Factor Problems in Night Operations. 1977. U.S. Army Research Institute for the Behavioral Sciences. Alexandria, Virginia.

Welford, A.T. Stress and Performance. Ergonomics. 1973. 16:567-580.

Welford, A.T. Skilled Performance: Perceptual and Motor Skills. 1976. Scott Foresman and Company. Glenview, Illinois.

West, V. & Parker, J.F. A Review of Recent Literature: Measurement and Prediction of Operational Fatigue. 1975. (Final Report) Office of Naval Research. Arlington, Virginia. NR 201- 067, FEB 1975. AD A008-405.

Wever, R. Circadian Rhythms of some Psychological Functions Under Different Conditions. In: Benson, A.J.,

ed., Rest and Activity cycles for the Maintenance of Efficiency of Personnel Concerned With Military Flight Operations. 1970. Aerospace Medical Panel Specialists Meeting. May, 1970. Oslo, Norway. Technical Editing and Reproduction Ltd. London. NATO/AGARD CP- 74-70.

Wilkinson, R.T. The Effect of Lack of Sleep on Visual Watch- keeping. 1960. Quarterly Journal of Experimental Psychology. 12:36-40.

Wilkinson, R.T. Interaction of Lack of Sleep with Knowledge of Results, Repeated Testing, and Individual Differences. 1961. Journal of Experimental Psychology. 62:263-271.

Wilkinson, R.T. Effect of up to 60 Hours of Sleep Deprivation on Different Types of Work. 1964. Ergonomics. 7:175-186.

Wilkinson, R.T. Sleep Deprivation. 1965. In O.G. Edholm & A. Bachrach (Eds), The Physiology of Human Survival. Academic Press. New York, N.Y. 28-43.

Wilkinson, R.T. Sleep Deprivation: Performance Tests for Partial and Selective Sleep Deprivation. 1969. Progress in Clinical Psychology. 8:28-43.

Wilkinson, R.T. Some Factors Influencing the Effect of Environmental Stresses Upon Performance. 1969. Psychological Bulletin. 72:260-272.

Wilkinson, R.T., Edwards, R.S., & Haines, E. Performance Following a Night of Reduced Sleep. 1966. Psychonomic Science. 5:471-472.

Williams, H.L., Lubin, A., & Goodnow, J.J. Impaired Performance with Acute Sleep Loss. 1959. Psychological Monographs. 73:1- 26.

Williams, H.L., Kearny, O.F., & Lubin, A. Signal Uncertainty and Sleep Loss. 1965. Journal of Experimental Psychology. 69:401- 407.

Williams, H.L., & Williams, C.L. Nocturnal EEG Profiles and Performance. 1966. Psychophysiology. 3:164-175.

Williams, H.L., Gieseking, C.F., & Lubin, A. Some Effects of Sleep Loss in Memory. 1966. Perceptual and Motor Skills. 23:1287-1293.

Woodward, D.P. & Nelson, P.D. A User Oriented Review of the Literature on the Effects of Sleep Loss, Work-Rest Schedules, and Recovery on Performance. 1974. Office of Naval Research. Washington, D.C. TR No. ACR 206, DEC 1974. AD A009-778.

Wright, P. The Harassed Decision Maker: Time Pressures, Distractions and the Use of Evidence. Journal of Applied Psychology. 1974. 59:555-561.

Yager, J. Personal Violence in Infantry Combat. Archives of General Psychiatry. 1975. 32:257-261.

Yntema, D.B., & Torgerson, W.S. Man-computer Cooperation in Decisions Requiring Common Sense. IRE Transactions of the Professional Group on Human Factors in Electronics. 1961. 2:20- 26.

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The anticipated nature of future land combat is analyzed with respect to the resulting demands on soldiers. Aspects of current infantry doctrine, casually-evolved behavior in the field, and human capacity are analyzed with respect to soldier's performance limits. Doctrine and research recommendations aimed at closing the gap between demands and performance limits are made.

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